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NASA TECH BRIEF

Marshall Space Flight Center

Ferrolubricants

The typical lubricants used on moving parts have a common problem. When the parts are not in motion, the lubricants flow back into reservoirs, leaving the frictional surfaces relatively dry. Once the parts start moving, it takes a few seconds for the lubricants to get back into circulation. In the meantime, the parts undergo excessive wear before the lubricants reach them. This problem can be resolved with ferrolubricants. The ferrolubricants have magnetized angstrom-size iron particles which stick the oil to the moving surfaces at all times, significantly reducing frictional wear.

Basically, a ferrofluid consists of very fine, angstrom-size ferromagnetic particles coated with a dispersing agent in a carrier base fluid. The magnetic particle absorbs the dispersing agent onto its surface and, thereby, is provided with an elastic repellant layer to other particles. The magnetic particle, which is usually about 100 angstroms in size or about the size of a red blood corpuscle, is small enough so that thermal agitation by liquid molecule impacts prevents particles from separating under gravity or strong magnetic fields. Any oversized particles are removed during formulation by ultracentrifugation in excess of 15,000 g's. The number of particles per unit volume is large, 10^{15} to 10^{20} particles per cubic centimeter, so the fluid has great homogeneity.

Such fluids remain unmagnetized in the absence of a magnetic field. Although the ferrite particles are subdomain in size and thus permanently magnetized, the disorienting effect of thermal agitation produces an unpolarized magnetic fluid. When a field is applied, the fluid develops a magnetic moment alined with the magnetic field. This moment increases linearly with increased field until it reaches a saturation level. Fluids produced to date have saturation levels in excess of 600 gauss and initial permeabilities up to 5.

Magnetic fluids can now be produced in families of various fluids having widely-varying chemical and physical properties. Magnetic fluids commercially available today include hydrocarbons, fluorocarbons, esters, water, silicones, and several solvents. The addition of magnetic particles to a base fluid has the predictable effect of increasing viscosity and density. Other properties such as wettability, miscibility, and surface tension are not as easily predicted. The feature of magnetic susceptibility in these fluids makes their potential applications innumerable. Three commercially feasible ferrolubricants have been recently studied, and the results are described and compared in a report.

Note:

Requests for further information may be directed to:

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Patent status:

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Categories: 04 (Materials)
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